APPENDIX E. ANALYSIS OF CONSENSUS STANDARDS

E.1 INTRODUCTION

This supplemental appendix contains analyses performed after stakeholders agreed to consensus efficiency standards for fluorescent lamp ballasts. The consensus standards apply to ballasts for the new and renovation market (sold as part of a fixture in the OEM market) manufactured as of April 1, 2005, sold by manufacturers as of July 1, 2005, or incorporated into luminaires by luminaire manufacturers as of April 1, 2006. The exception is ballasts for the replacement market; replacement ballasts manufactured as of June 30, 2010, must meet the standard. It was assumed that 70 percent of magnetic ballasts are sold through OEMs and 30 percent are replacement ballasts. The analyses contained herein include the following: national energy savings (NES) (includes NPV), national employment impact, utility impact and environmental assessment. We report the results obtained when the consensus standards were analyzed under three base case shipments scenarios. Two of these shipments scenarios were essentially the same as before. A constant shipments case was added. These three shipments forecasts are described more fully in the next section of this appendix.

There has been a change in the analysis of HO ballasts. The revised standard will keep the BEF at the existing standard level for HO ballasts. However, a class of HO ballasts that was previously exempted from standards because of their operation at low temperatures will now be covered. At the time (1988) that the previous standards were established, energy-efficient magnetic HO ballasts were not designed to operate below 50 degrees F and therefore "cold temperature" HO ballasts (rated to start at 0 degrees F or lower) were exempted. Currently, EEM cold temperature HO ballasts are manufactured, so the exemption will be removed for most of them (some ballasts used for outdoor signs and operating at -20 degrees F or lower will still be exempted). Under the new standards, most cold temperature HO ballasts will now have to meet the existing standard BEF; that essentially means they must be EEM ballasts.

E.2 NATIONAL ENERGY SAVINGS AND NPV

E.2.1 Shipments Scenarios

The consensus standards were analyzed using three base case shipments scenarios: Decreasing Shipments to 2015, Decreasing Shipments to 2027, and Constant Shipments. The first two scenarios were identical to those described in Chapter 5 (sections 5.2.1 and 5.3.1). For Decreasing Shipments to 2015, the magnetic T12 ballast shipments decrease to 10 percent of their 1997 value by 2015, and remain constant at that level through 2030. For Decreasing Shipments to 2027, the magnetic T12 ballast shipments decrease to 10 percent of their 1997 value by 2027, and remain constant at that level through 2030. An exception for the two declining shipments cases is that shipments for HO ballasts remain constant at 1 million per year for the whole analysis period (see Scenario Assumptions below).

The third scenario, Constant Shipments, assumes that magnetic T12 ballast shipments remain constant at 1997 levels throughout the period. However, because of the way the NES model operates, the shipments are not actually constant until 2009. The model uses the Ballast Weights (described in Appendix B, section B.2, Weights Menu, and section B.3) to calculate the number of 1-lamp F40T12 ballasts used in 3-lamp non-tandem-wired fixtures. Because the ballast weights are assumed to change from 1997 to 2009, the shipments for those 1-lamp ballasts increase each year during that period, becoming constant in 2009. Shipments for the other ballast categories (2-lamp F40T12 ballasts, 1-lamp F40T12 ballasts in 1-lamp fixtures, 2-lamp F96T12 ballasts and 2-lamp F96T12/HO ballasts) are constant at 1997 levels. Total magnetic T12 ballast shipments become constant at a slightly higher level than 1997 shipments and remain at that level through 2030. The increase is about 5 percent relative to1997 shipments (2 percent relative to 2005 shipments). Details may be viewed in the NES model, Shipments worksheet, using Constant Shipments in the Shipments menu.

E.2.2 Scenario Assumptions

The consensus standards scenario assumed that the standards took effect in 2005. We modeled the electronic ballast trial standard level. The NES model assumes that a standard takes effect in January 1st of the start year; we did not adjust the results to account for the April 1 start date since the difference would be small. There was a delay period of 5 years for the replacement ballast market. This delay did not apply to HO ballasts; the standard for all HO ballasts was assumed to be effective April 1, 2005. The new/renovation market was assumed to comprise 70 percent of magnetic ballast shipments and to become 100 percent T8 electronic ballasts under the standard. The replacement market was assumed to comprise 30 percent of magnetic ballast shipments and to become 95 percent T8 electronic and 5 percent T12 electronic. The ballast assumptions (ballast price, energy savings, labor costs, lamp costs, and equipment lifetimes) as well as the ballast weights were the same as those described in the scenarios in Chapter 5, with the exception of the F96T12HO energy savings and ballast prices, as described below. As for those scenarios, the social discount rate was 7 percent real and the NPV savings and costs were discounted to 1997. The results were modeled for the AEO Reference Case electricity price forecast. While the consensus standard includes a date of April 1st, 2005 for ballasts sold by manufacturers and April 1st, 2006 for ballasts sold in luminaires, we used the simplifying assumption that the standards took full effect in 2005 for all ballasts in the new/renovation market.

In the NES model, instead of analyzing HO ballasts shifting from EEM to ERS ballasts as done for the Chapter 5 scenarios, we analyzed the cold temperature HO ballasts shifting from standard magnetic to EEM ballasts. The impact of this change yielded greater savings for the HO ballast category, since the savings gained from removing the cold temperature HO exemption were larger than those lost from keeping the HO ballast BEF at the existing EEM levels. The end-user price increased from about $20.20 for the standard magnetic ballast to about $31.95 for the energy efficient magnetic ballast. The unit energy savings was estimated at 12 Watts and operating hours were estimated at 4500 hrs/year which resulted in a unit annual energy savings of 54 kWh. The shipments of these ballasts were estimated at about one million per year. In the base case, it was assumed that HO ballast shipments remained constant and that there were no conversions from standard magnetic to energy-efficient magnetic ballasts.

The consensus standards scenarios run with the three shipments base cases were named 7a (Decreasing Shipments to 2015), 7b (Decreasing Shipments to 2027), and 7c (Constant Shipments). The results are shown in Table E.1 below.

E.2.3 National Energy Savings and NPV

This section presents the summary of results for the three standards scenarios, as well as the detailed results by lamp-ballast combination.

We estimated that the base case cumulative fluorescent lighting energy consumption for the period from 2005 to 2030 was approximately 85 Quads or 90 exajoules (source energy) for the Decreasing Shipments to 2027 base case. The calculation method was the same as that described in Chapter 5 (section 5.3.6, Energy Consumption) with the total summed from 2005 instead of 2003. The savings from the consensus standards for the 2027 base case was about 2.7 percent of this total estimated consumption.

Table E.1 Energy Savings and Net Present Value to Society of Standards for Fluorescent Ballasts Purchased from 2005-2030 (1997 Billion Dollars, Discounted to 1997 at 7 percent Real)

Electronic Standards			
For Units Sold from 2005 to 2030 Discounted at 7% to 1997 (in billion 1997 $)			
SCENARIO	***Scen 7A*** ***Decr2015***	***Scen 7B*** ***Decr2027***	***Scen 7C*** ***Constant***
Total Quads Saved	1.20	2.32	4.90
Total Quads Saved w/HVAC*	1.27	2.46	5.21
Total Exajoules Saved	1.27	2.45	5.17
Total Exajoules Saved w/ HVAC*	1.34	2.60	5.50
Total Benefit	1.95	3.51	7.24
Total Equipment Cost	0.53	0.91	1.83
Net Present Value	1.42	2.60	5.41
*For energy savings only; Total Benefit and Net Present Value do not include HVAC savings.			

Table E.2 Scenario 7a

For Units Sold from 2005 to 2030

Discounted at 7% to 1997 (in billion 1997 $)

	2F40	*1F40*	*2F96/ES*	*2F96HO/ES*	*Total*
Total Quads Saved	**0.88**	**0.02**	**0.17**	**0.12**	**1.20**
Total Quads Saved w/ HVAC	**0.94**	**0.02**	**0.18**	**0.13**	**1.27**
Total Benefit	**1.51**	**0.04**	**0.29**	**0.11**	**1.95**
Total Equipment Cost	**0.25**	**0.01**	**0.17**	**0.09**	**0.53**
Net Present Value	**1.25**	**0.03**	**0.11**	**0.03**	**1.42**

Table E.3 Scenario 7b

For Units Sold from 2005 to 2030

Discounted at 7% to 1997 (in billion 1997 $)

	2F40	*1F40*	*2F96/ES*	*2F96HO/ES*	*Total*
Total Quads Saved	**1.81**	**0.05**	**0.34**	**0.12**	**2.32**
Total Quads Saved w/ HVAC	**1.92**	**0.05**	**0.37**	**0.13**	**2.46**
Total Benefit	**2.79**	**0.07**	**0.53**	**0.11**	**3.51**
Total Equipment Cost	**0.47**	**0.02**	**0.32**	**0.09**	**0.91**
Net Present Value	**2.32**	**0.05**	**0.20**	**0.03**	**2.60**

Table E.4 Scenario 7c

For Units Sold from 2005 to 2030

Discounted at 7% to 1997 (in billion 1997 $)

	2F40	*1F40*	*2F96/ES*	*2F96HO/ES*	*Total*
Total Quads Saved	**3.93**	**0.10**	**0.74**	**0.12**	**4.90**
Total Quads Saved w/ HVAC	**4.17**	**0.11**	**0.79**	**0.13**	**5.21**
Total Benefit	**5.86**	**0.16**	**1.11**	**0.11**	**7.24**
Total Equipment Cost	**1.00**	**0.05**	**0.69**	**0.09**	**1.83**
Net Present Value	**4.85**	**0.11**	**0.42**	**0.03**	**5.41**

E.3 NET NATIONAL EMPLOYMENT

Net national employment impacts from ballast standards were defined as net jobs created or eliminated in the general economy as a consequence of reduced spending by commercial and industrial sector businesses on electricity, increased spending on the purchase price of ballasts and reduced spending on new power plants by the utility industry (along with the indirect effects of these three factors). Figure E.1 shows the estimated net national employment impact of three different electronic ballast standards scenarios that are described in the NES results section (E.2).

These results came from our use of an input/output model of the U.S. economy to estimate the effects of standards on different major sectors of the U.S. economy most relevant to buildings and their net impact on jobs. The impacts of new ballast standards were estimated in the NES spreadsheet as energy savings (reduced electricity use), energy cost savings, and increased ballast purchase prices. These three impacts (see Figures E2-E4 below) were output from NES and input to ImBuild. Direct employment impacts, which would occur at ballast manufacturing plants, are discussed in the Manufacturer Impact Analysis results section in this appendix.

The results shown here do not include a late change for HO ballasts (described earlier in this appendix). The impact of not including the change for HO ballasts is expected to be very small since the change in both equipment costs and energy savings are very small. For example, the cumulative energy savings for scenarios 7a, 7b and 7c increase by 10%, 4% and 1%, respectively, relative to the values used to generate Figure 1.

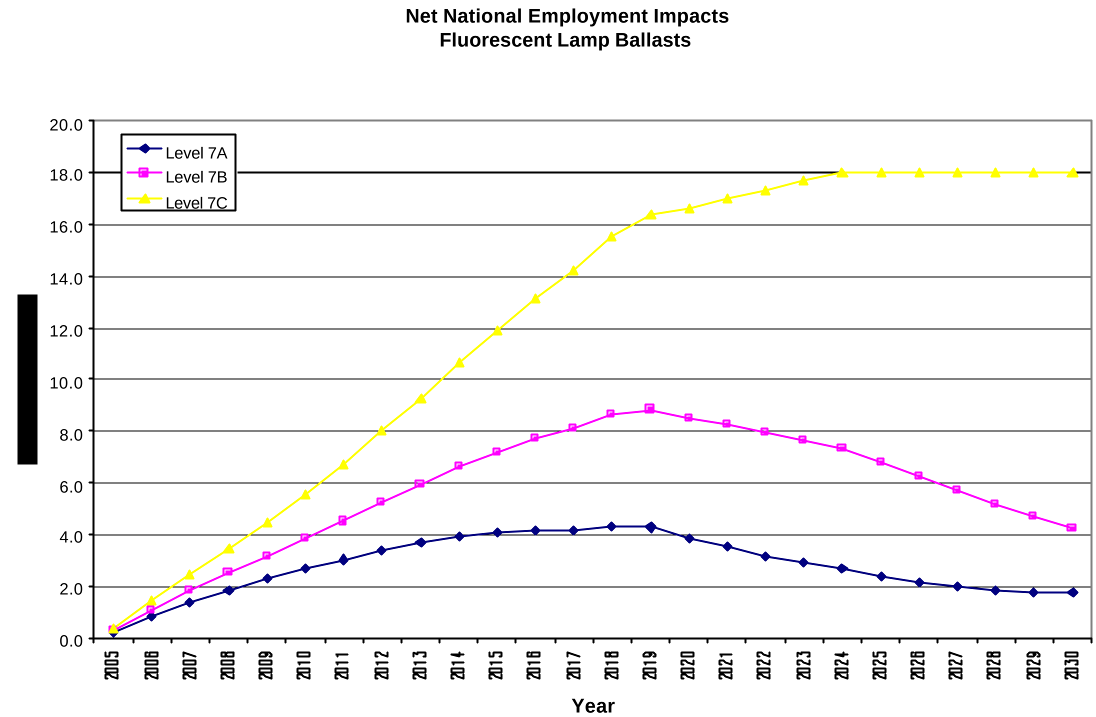

Figure E.1 Net National Employment Impacts

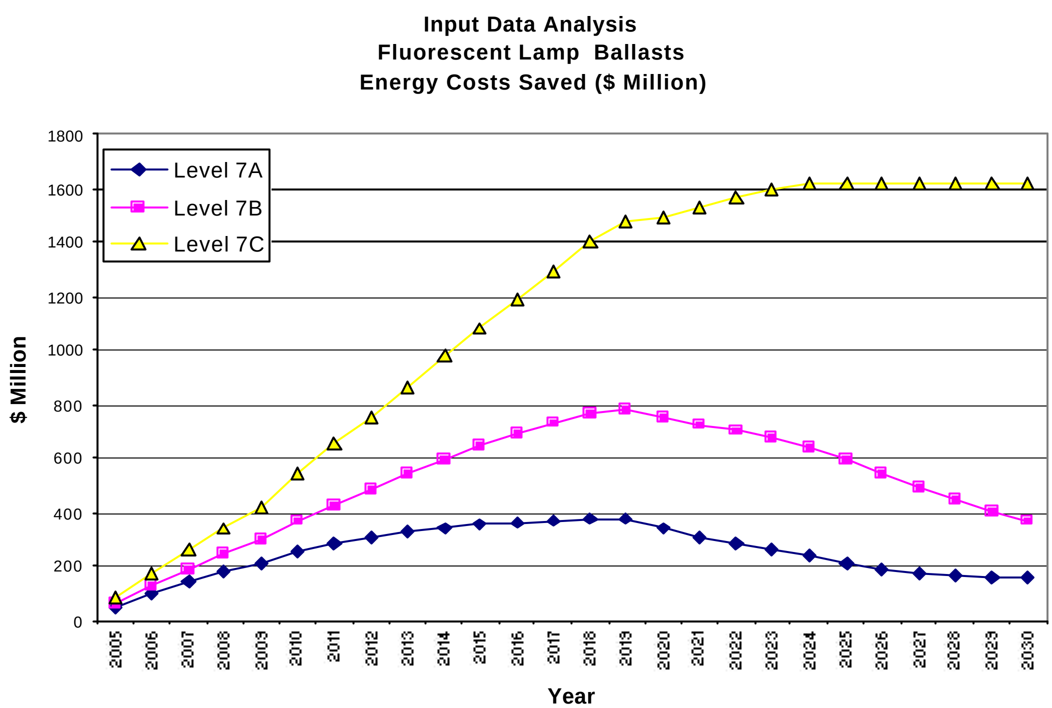

Figure E.2 Energy Costs Saved

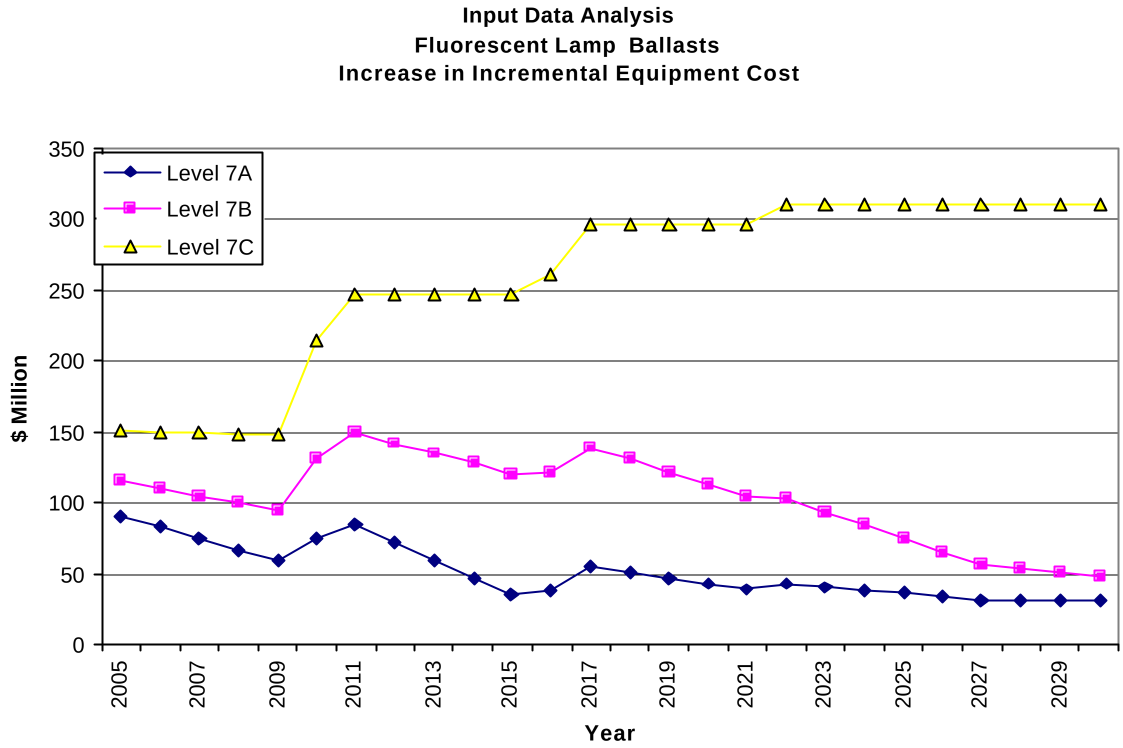

Figure E.3 Increase in incremental equipment cost

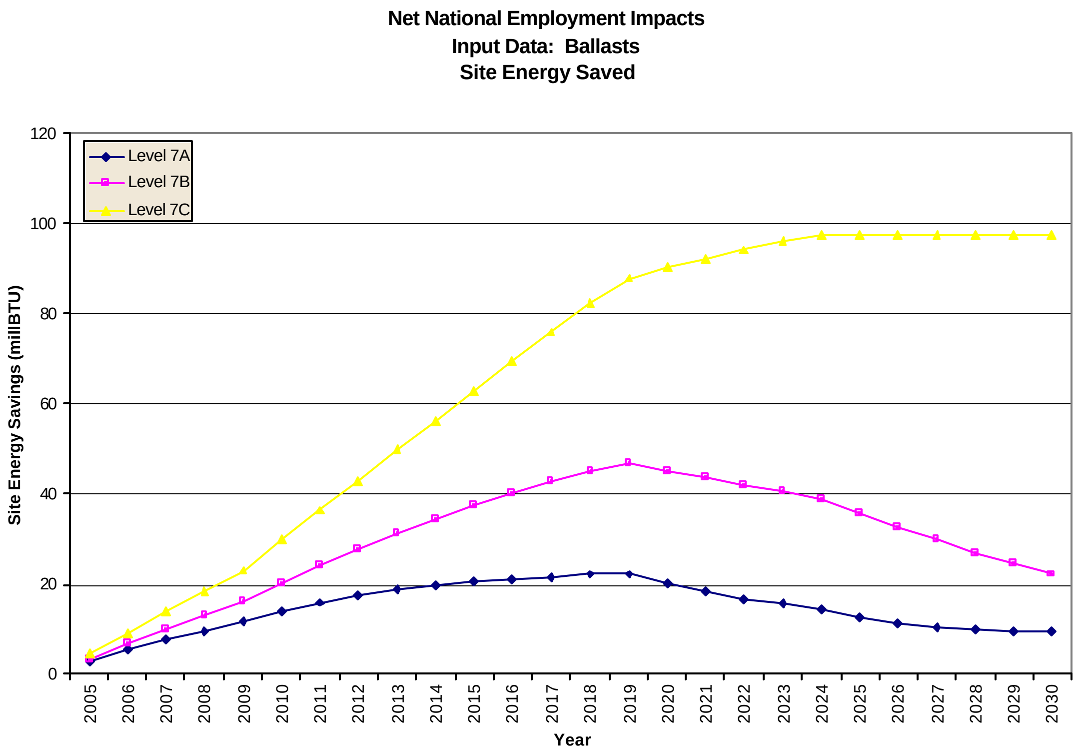

Figure E.4 Site energy saved

E.4 UTILITY IMPACT

Results for trial standard level 7 are presented in Tables E.5 through E.7 for each of the three cases, a, b, and c. Although energy savings from the proposed ballast standards continue through 2030, the effects of these savings are reported through 2020 because this is the NEMS-BRS time horizon. Each table shows forecasts using interpolated results as described above for commercial energy sales and total U.S. electric generation and installed capacity. As expected, gas-fired generation is more affected by the standard levels than coal-fired generation. This effect reflects the peaking nature of the ballast end use, and the fact that gas generation, in general, is used to serve this peak. However, effects of standards on installed capacity are small relative to the energy savings.[1]

Commercial energy sales fall for all three standard 7 scenario cases compared to the AEO99 Reference Case. The decrease in sales is proportional to the amount of energy that the National Energy Savings (NES) model predicts will be saved by each standard, from 0.5% to 1.9% of total commercial electricity sales in the peak savings year reported. Total U.S. generation decreases relative to the AEO99 baseline in each standards case, from just under 0.6% of total U.S. electric generation in the peak savings year of the maximum savings case (standard scenario 7c) to 0.2% in the peak year of the smallest savings case (standard scenario 7a). Total installed capacity is also slightly reduced in each standard level scenario, by just under 0.5% in the final year of the maximum savings case.

[1] Capacity factor, a ratio of generation to installed capacity, is an indicator of the robustness of the forecast. The implied capacity factors of the displaced capacity in this forecast are within reasonable limits.

Table E.5 Standard Scenario 7a Forecast

NEMS-NAECA Results: Standards Level	2000	2005	2010	2015	2020	Difference from AEO99 Reference	2000	2005	2010	2015	2020
Commercial-Sector Energy Consumption						*Commercial-Sector Energy Consumption*					
Electricity Sales (TWh)	1,081	1,161	1,244	1,326	1,378	Electricity Sales (TWh)	0.0	-0.8	-4.1	-6.0	-6.0
Total U.S. Electric Generation						*Total U.S. Electric Generation*					
Coal (TWh)	1,990	2,037	2,091	2,202	2,344	Coal (TWh)	0.0	-0.3	-0.5	-1.7	-3.6
Gas (TWh)	547	858	1,145	1,437	1,586	Gas (TWh)	0.0	-0.5	-3.6	-4.4	-2.5
Petroleum (TWh)	109	44	35	33	31	Petroleum (TWh)	0.0	0.0	0.0	0.0	0.0
Nuclear (TWh)	660	631	554	419	359	Nuclear (TWh)	0.0	0.0	0.0	0.0	0.0
Renewables (TWh)	423	433	446	461	483	Renewables (TWh)	0.0	0.0	0.0	-0.2	-0.3
Total (TWh)	3,729	4,002	4,272	4,552	4,803	Total (TWh)	0.0	-0.7	-4.1	-6.3	-6.4
Installed Generating Capacity						*Installed Generating Capacity*					
Coal (GW)	315.2	315.0	318.9	326.0	343.0	Coal (GW)	0.0	0.0	0.0	-0.2	-0.5
Other Fossil (GW)	301.5	369.7	396.8	469.0	512.8	Other Fossil (GW)	0.0	0.0	-0.5	-1.1	-0.7
Nuclear (GW)	94.8	87.4	74.2	56.4	48.9	Nuclear (GW)	0.0	0.0	0.0	0.0	0.0
Renewables (GW)	97.2	98.9	100.3	102.3	105.4	Renewables (GW)	0.0	0.0	0.0	0.0	0.0
Total (GW)	808.7	871.0	890.1	953.7	1,010.1	Total (GW)	0.0	0.0	-0.6	-1.3	-1.2

Table E.6 Standard Scenario 7b Forecast

NEMS-NAECA Results: Standards Level						Difference from AEO99 Reference					
	2000	**2005**	**2010**	**2015**	**2020**		**2000**	**2005**	**2010**	**2015**	**2020**
Commercial-Sector Energy Consumption						*Commercial-Sector Energy Consumption*					
Electricity Sales (TWh)	1,081	1,161	1,242	1,321	1,371	Electricity Sales (TWh)	0.0	-1.0	-5.9	-11.0	-13.3
Total U.S. Electric Generation						*Total U.S. Electric Generation*					
Coal (TWh)	1,990	2,037	2,091	2,201	2,342	Coal (TWh)	0.0	-0.3	-0.6	-2.7	-6.5
Gas (TWh)	547	857	1,144	1,433	1,581	Gas (TWh)	-0.1	-0.6	-5.3	-8.4	-7.2
Petroleum (TWh)	109	44	35	33	31	Petroleum (TWh)	0.0	0.0	0.0	0.0	0.0
Nuclear (TWh)	660	631	554	419	359	Nuclear (TWh)	0.0	0.0	0.0	0.0	0.0
Renewables (TWh)	423	433	446	461	482	Renewables (TWh)	0.0	0.0	-0.1	-0.2	-0.6
Total (TWh)	3,729	4,002	4,270	4,547	4,795	Total (TWh)	-0.1	-0.9	-6.0	-11.4	-14.3
Installed Generating Capacity						*Installed Generating Capacity*					
Coal (GW)	315.2	315.0	318.9	326.0	342.7	Coal (GW)	0.0	0.0	0.0	-0.2	-0.8
Other Fossil (GW)	301.5	369.7	396.5	468.2	511.6	Other Fossil (GW)	0.0	0.0	-0.8	-1.9	-1.9
Nuclear (GW)	94.8	87.4	74.2	56.4	48.9	Nuclear (GW)	0.0	0.0	0.0	0.0	0.0
Renewables (GW)	97.2	98.9	100.3	102.3	105.4	Renewables (GW)	0.0	0.0	0.0	0.0	0.0
Total (GW)	808.7	871.0	889.9	952.9	1,008.5	Total (GW)	0.0	0.0	-0.8	-2.1	-2.8

Table E.7 Standard Scenario 7c Forecast

NEMS-NAECA Results: Standards Level	2000	2005	2010	2015	2020	Difference from AEO99 Reference	2000	2005	2010	2015	2020
Commercial-Sector Energy Consumption						*Commercial-Sector Energy Consumption*					
Electricity Sales (TWh)	1,081	1,161	1,239	1,314	1,358	Electricity Sales (TWh)	0.0	-1.3	-8.7	-18.4	-26.4
Total U.S. Electric Generation						*Total U.S. Electric Generation*					
Coal (TWh)	1,990	2,036	2,091	2,200	2,337	Coal (TWh)	0.0	-0.5	-0.7	-4.4	-11.5
Gas (TWh)	547	857	1,141	1,427	1,572	Gas (TWh)	-0.1	-0.6	-7.7	-14.4	-15.6
Petroleum (TWh)	109	44	35	33	31	Petroleum (TWh)	0.0	0.0	0.0	0.0	0.0
Nuclear (TWh)	660	631	554	419	359	Nuclear (TWh)	0.0	0.0	0.0	0.0	0.0
Renewables (TWh)	423	433	446	461	482	Renewables (TWh)	0.0	0.0	-0.1	-0.3	-1.0
Total (TWh)	3,729	4,002	4,267	4,539	4,781	Total (TWh)	-0.1	-1.1	-8.5	-19.1	-28.1
Installed Generating Capacity						*Installed Generating Capacity*					
Coal (GW)	315.2	315.0	318.9	325.8	342.1	Coal (GW)	0.0	0.0	0.0	-0.4	-1.4
Other Fossil (GW)	301.5	369.6	396.1	467.1	509.9	Other Fossil (GW)	0.0	-0.1	-1.2	-3.0	-3.6
Nuclear (GW)	94.8	87.4	74.2	56.4	48.9	Nuclear (GW)	0.0	0.0	0.0	0.0	0.0
Renewables (GW)	97.2	98.9	100.3	102.3	105.4	Renewables (GW)	0.0	0.0	0.0	0.0	0.0
Total (GW)	808.7	870.9	889.5	951.6	1,006.2	Total (GW)	0.0	-0.1	-1.2	-3.4	-5.1

The results shown here do not include a late change for HO ballasts (described earlier in this appendix). The impact of not including the change for HO ballasts is expected to be very small since the change in energy savings are very small. For example, the cumulative energy savings for scenarios 7a, 7b and 7c increase by 10%, 4% and 1%, respectively, relative to the values used to generate the utility impacts above.

E.5 ENVIRONMENTAL IMPACT

As described above, the results for the environmental analysis are comparable to a complete NEMS-BRS run. Although energy savings from the proposed appliance standards continue through 2030, the effects of these savings are reported through 2020 because this is the time horizon of NEMS-BRS. Total carbon and NO_x emissions for each of the 3 cases of standard scenario 7 are reported in Table E.8. The annual carbon emission reductions range up to 4.0 Mt in 2020 and the NO_x emissions reductions up to 8.8 kt in the same year.[2, 3]

Table E.8 Power Sector Emissions: Electronic Ballast Standard Scenarios

NEMS-NAECA Results						Difference from AEO99 Reference					
	2000	**2005**	**2010**	**2015**	**2020**		**2000**	**2005**	**2010**	**2015**	**2020**
AEO99 Reference											
Carbon (Mt/a)[1,3]	588.9	612.9	653.2	704.6	744.6						
NOx (kt/a)[2,3]	4,191.2	3,547.1	3,665.0	3,819.2	3,882.8						
Standard Scenario 7a											
Carbon (Mt/a)	588.9	612.8	652.7	703.8	743.6	Carbon (Mt/a)	0.0	-0.1	-0.5	-0.8	-1.0
NOx (kt/a)	4,191.2	3,546.2	3,663.0	3,817.0	3,881.3	NOx (kt/a)	0.0	-0.9	-2.0	-2.3	-1.5
Standard Scenario 7b											
Carbon (Mt/a)	588.9	612.7	652.4	703.1	742.6	Carbon (Mt/a)	0.0	-0.2	-0.8	-1.5	-2.0
NOx (kt/a)	4,191.2	3,546.1	3,662.1	3,814.8	3,878.8	NOx (kt/a)	0.0	-1.0	-2.9	-4.5	-4.0
Standard Scenario 7c											
Carbon (Mt/a)	588.9	612.7	652.2	702.1	740.6	Carbon (Mt/a)	0.0	-0.2	-1.0	-2.5	-4.0
NOx (kt/a)	4,191.2	3,545.3	3,661.8	3,810.9	3,873.9	NOx (kt/a)	0.0	-1.8	-3.2	-8.4	-8.8

[1]Comparable to Table A17 of AEO99: Electric Generators

[2]Comparable to Table A8 of AEO99: Emissions

[3]All results in metric tons (t), equivalent to 1.1 short tons

[2]million metric tons (Mt)

[3]thousand metric tons (kt)

Cumulative emissions savings over the 18-year period modeled are listed below for the three cases of standard scenario 7:

Table E.9 Cumulative Emissions Reductions (2003-2020)

Emission	Standard 7a	Standard 7b	Standard 7c
Carbon (Mt)	10.9	19.0	32.1
NOx (kt)	34.0	59.6	103.4

The results shown here do not include a late change for HO ballasts (described earlier in this appendix). The impact of not including the change for HO ballasts is expected to be very small since the change in energy savings are very small. For example, the cumulative energy savings for scenarios 7a, 7b and 7c increase by 10%, 4% and 1%, respectively, relative to the values used to generate the results in Table E.9.